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Embedded System for Vehicle Cabin Toxic Gas Detection and Alerting

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Abstract

Motor vehicles are the prime source of transportation where vehicles with A/C play a major part. This paper designs an embedded system for a vehicle cabin, which senses the gases like carbon-monoxide and oxygen and displayed at each and every second. If the level of the CO increases than the normal level (30ppm) or the level of the oxygen decreases than the normal level (19%) then an alarm is generated automatically and also ventilation is provided immediately. A warning message is sent to the authorized user via GSM. The advantage of this system is proper detection and faster response time leading to faster diffusion of the situation, compared manual method.

Keywords- Atmel microcontroller; Embedded System; Gas detecting sensors; GSM Modem; Vehicle Safety.

1. Introduction:

This type of equipment is used inside a vehicle cabin such that the presence or leakage of toxic gases can be detected by the gas sensorsand proper precautions can be taken to avoid the driver from getting fatigue or drowsiness. This designs an embedded system for toxic gas CO and oxygen level detection in vehicle cabin and to develop a sensing system using a sensor array and microcontroller. If the toxic gas reaches the maximum threshold level, the detection unit detects and the ventilation will be provided automatically. And then sends an SMS to the authorized user through the GSM module.

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2. Hardware Description:

2.1. Atmel 89c51

The AT89c51 is a low power high performance CMOS 8 bit microcomputer of flash programmable and erasable read only memory. It is compatible with the industry standard MCS-51 instruction set and pin out. The on-chip flash allows the program memory to be reprogrammed in system or by a conventional non-volatile memory programmer. By combining a versatile 8 bit CPU with flash on a monolithic chip the AT89c51 provides a highly flexible and cost effective solution to many embedded control application.

2.2. Carbon Monoxide (CO) sensors:

A CO sensor is a device that detects the presence of the CO gas in order to prevent the CO poisoning. CO is a colourless and odourless compound produced by incomplete combustion. It is often referred to as "Silent killer" because it is virtually undetectable without using detection technology. Elevated levels of CO can be dangerous to humans depending on the amount present and length of exposure. Smaller concentration can be harmful over longer periods of times to be harmful.

Features:

- High sensitivity
- Detection Range: 10-1000rpmCO
- Response time :< 150s
- Heater voltage: 5.0V
- Dimensions: 16 mm diameter, 10 mm high excluding pin, pins-6 mm High.

2.3. Oxygen Sensors:

Amperometric gas sensors (AGS; sometimes called electrochemical gas sensors) have properties that make them attractive for long term monitoring application and real time measurement, process, control, and safety applications. They are simple in structure, reliable and rugged in use, and modest in cost. Power consumption is low. This has been sufficient to make sensors irreplaceable in toxic gas alarms.

2.4. A/D Converter:

The ADC0808 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The ADC0808 offers high speed, high accuracy, minimal temperature dependence, excellent long-term accuracy and repeatability, and consumes minimal power. These make this device ideally suitable for applications process and machine control to consumer and automotive applications.

2.5. Alarm Circuit:

Safety alarms are electronic alarms designed to alert the user to a specific danger. Sensors are connected to a control unit via low-voltage wiring or a narrow band RF signal which is used to interact with a response device.

2.6. GSM modem:

GSM (Global System for Mobile Communications: originally from Group Special Mobile) is the most popular standard for mobile telephony systems in the world. The GSM association has its promoting industry trade organization of mobile phone carriers and manufactures, estimate that 80% of the global mobile market uses this standard. A GSM modem is wireless modem that works with a GSM wireless network. GSM modem requires a SIM card from a wireless carrier in order to operate. The connection between the modem is shownin Fig.1.

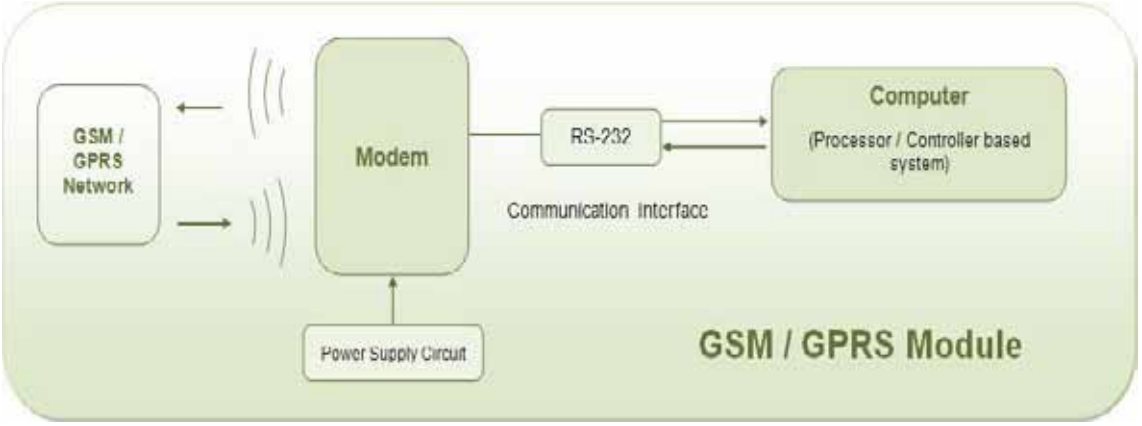

Fig.1 GSM Modem Connection

A GSM available service like SMS (Short Message Service) represents alternative modalities to make remote measurements and control. SMS service is suited for remote control applications that requires small amount of data and rare activation, like sending alarms, or emergency commands. The system can be interconnected with the car alarm system and alert the owner, on his mobile phone. The system is composed by a microcontroller and a GSM phone. The connection can normally wireless and the modem or the GSM module is connected via RS-232 cable with the system and then GPRS could be activated.

3. Software Description:

The keil C51 C compiler for the 8051 microcontroller is the most popular 8051 C compiler in the world. It provides more features than any other 8051 C compiler available today. The microcontroller applications that are written in C and once complied using the C51 compiler have the efficiency and speed of the assembly language.

The C51 compiler translates the C source files into re-locatable object modules which contain full symbolic information for debugging with micro vision debugger or an in-circuit emulator.

3.1. Embedded C

Embedded C is not a part of the C language as such. Rather, it is a C language that is the subject of a technical report by the ISO working group named “Extensions for the Programming Language C to support Embedded Processors”. It aims to provide portability and access to common performance-

increasing features of processors used in domain of the DSP and embedded processing. The embedded C's specification for fixed-point, named address spaces, and named registers gives the programmer direct access to the features in the target processor and there by significantly improving the performance of the applications. The hardware I/O extension is a portability feature of Embedded C and its goal is to allow easy porting of device-driver code between the systems.

Embedded C is designed to bridge the performance mismatch between the Standard C and the embedded hardware and application architecture. It extends the C language with the primitives that are needed by signal-processing applications and that are commonly provided by the DSP processors.

Embedded C makes life easier for application programmers. The primitives provided are the primitives that fit the conceptual model of the application which brings back the roots of C to the embedded systems as primarily a high-level language means of accessing the processor.

3.2. Embedded Software Development

There are several different ways of writing code for embedded systems depending on the complexity of the system and the amount of time and the money that can be spent. Developing software for ready-built hardware is generally easier than for discrete designs. Not only are hardware problems removed or at least they should have been but here is more software support available to overcome the obstacles of downloading and debugging code. Many ready built designs provide libraries and additional software support which dramatically cut the development time.

Fig.2Embedded Software Development

The traditional method of writing code has centred on a two pronged approach based on the use of microprocessor emulation. The software engineer would develop code on a PC, workstation or development system, and then use the emulator as a window into the system. With the emulator, it would be possible to download code, and trace and debug as shown in Fig.2.

4. Results and Discussion

The level of the toxic gas CO is continuously sensed by the sensor MQ-7. The level is displayed in the LCD continuously for every second. When the level of the toxic gas CO exceeds the normal level of 30ppm or the level of Oxygen decreases than the normal level of 19.5%, then the microcontroller proceeds with an alarm.

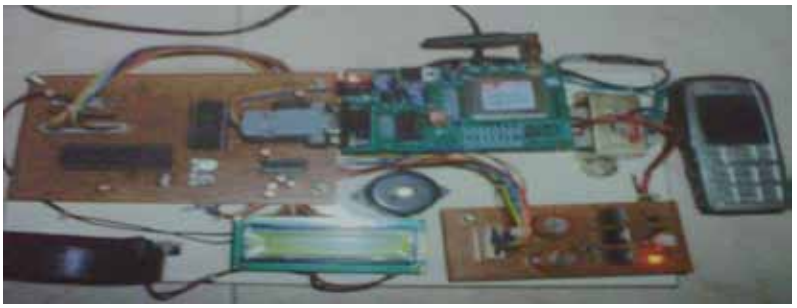

Fig 3. Prototype of the Proposed System

The GSM modem inside the vehicle sends a message to the authorized user about the alarming situation inside the cabin with the level of the gases monitored by the sensors. Then ventilation is provided, so that the level of the toxic gases can be lowered as early as possible. This provides an immediate response to the situation which is an added advantage of the system. The prototype of the proposed system is shown in Fig.3.

5. Conclusion

An embedded system is designed and tested for toxic gas detection inside a vehicle cabin using ATMEL 89C51 microcontroller. Toxic gas like CO is less sensible by human which endangers the human lives. This critical situation can be avoided by implementing the sensors for sensing the level of CO and oxygen level and is displayed every second. When the CO level exceeds normal level that is CO is greater than 30ppm and if the Oxygen level decreases below the normal level of 19ppm then the designed system provides an alarm and also the warning message to the authorized user. Ventilation is immediately provided in the cabin, whenever this critical situation occurs.

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